TO ALL WHOM IT MAY CONCERN:-

Be it known that I, Nikola Tesla, formerly of Smilj Lika Border country of Austro-Hungary, now residing at Rahway, in the County of Union and State of New Jersey, United States of America Electrician, have invented certain Improvements in Electric Arc Lamps of which the following is a specification.

My invention relates more particularly to those arc lamps in which the separation and feed of the carbon electrodes, or their equivalents, is accomplished by means of electro-magnets or solenoids in connection with suitable clutch mechanism and it is designed to remedy certain faults common to the greater part of the lamps heretofore made. The objects of my invention are to prevent the frequent vibrations of the movable electrode and flickering of the light arising therefrom, to prevent the electrodes falling into contact, to dispense with the dash pot, clockwork or gearing and similar devices heretofore used and to render the lamp extremely sensitive and to feed the carbon almost imperceptibly, and thereby obtain a very steady and uniform light.

In my present invention I further provide means for automatically withdrawing a lamp from the circuit, or cutting out the same, when, from a failure of the feed the arc reaches an abnormal length, and also means for automatically reinserting such lamp in the circuit when the rod drops and the carbons come into contact.

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My invention will be understood with reference to the accompanying drawings, in which

Fig. 1 is an elevation of the lamp with the case in section.

Fig. 2 is a sectional plan at the line $x^2 x^2$.

Fig. 3 is an elevation of the lamp partly in section at right angles to Fig. 1.

Fig. 4 is a sectional plan at the line y y, Fig. 1.

Fig. 5 is a section of the clamp in about full size.

Fig. 6 is a detached section illustrating the connection of the spring to the lever that carries the pivots of the clamp, and

Fig. 7 is a diagram showing the circuit connections of the lamp.

M, represents the main, and N the shunt magnets both securely fastened to the base A which with its side column S. S. is preferably cast in one piece of brass or other diamagnetic material. To the magnets are soldered or otherwise fastened the brass washers or disks a, a, a, a. Similar washers b, b, of fibre or other insulating material serve to insulate the wires from the brass washers.

The magnets M and N are made very flat so that their width exceeds three times their thickness, or even more. In this way a comparatively small number of convolutions is sufficient to produce the required magnetism; besides a greater surface is offered for cooling off the wires.

The upper pole pieces m, n, of the magnets are curved as indicated in the drawing Fig. 1; the lower pole pieces m-′, n-′, are brought near together tapering towards the armature g, as shown in Figs. 2 and 4. The object of this taper is to concentrate the greatest amount of the developed magnetism upon the armature and also to allow the pull to be exerted always upon the middle of the armature g. This armature g, is a piece of iron in the shape of a hollow cylinder having on each side a segment cut away, the width of which is equal to the width of the pole pieces m-′, n-′.

The armature is soldered or otherwise fastened to the clamp r, which is formed of a brass tube provided with gripping jaws e, e, Fig. 5. These jaws are arcs of a circle of the diameter of the rod R, and are made of some hard metal, preferably of hardened German silver. I also make the guides f, f, through which the carbon holding rod R, slides, of the same material. This has the advantage to reduce greatly the wear and corrosion of the parts coming in frictional contact with the rod which frequently causes trouble. The jaws e, e, are fastened to the inside of the tube r, so that one is a little lower than the other. The object of this is to provide a greater opening for the passage of the rod when the same is released by the clamp.

The clamp r, is supported on bearings w, w, Figs. 1, 3 & 5, which are just in the middle between the jaws e, e, I find this disposition to be the best. The bearings w, w, are carried by a lever t, one end of which rests upon an adjustable support q, of the side columns S, the other end being connected by means of the link e-′ to the armature lever L.

The armature lever L is a flat piece of iron in Z shape having its ends curved so as to correspond to the form of the upper pole pieces of the magnets M and N. It is hung upon the pivots v, v, Fig. 2, which are in the jaw x, of the top plate B. This plate B, with the jaw is preferably cast in one piece and screwed to the side columns S. S. that extend up from the base A.

To partly balance the overweight of the moving parts a spring s′, Figs. 2 and 6, is fastened to the top plate B, and hooked to the lever t. The hook e, is towards one side of the lever or bent a little sideways, as seen in Fig. 6. By this means a slight tendency is given to swing the armature towards the pole piece m′, of the main magnet.

The binding posts K, K′, are preferably screwed to the base A. A manual switch for short-circuiting the lamp when the carbons are renewed is also to be fastened to the base. This switch is of ordinary character and is not shown in the drawing.

The rod R, is electrically connected to the lamp frame by means of a flexible conductor or otherwise. The lamp case receives a removable ornamental cover s-2 around the same to enclose the parts.

The electrical connections are as indicated diagramatically in Fig. 7.

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The wire in the main magnet consists of two parts x' and p'. These two parts may be in two separated coils or in one single helix as shown in the drawing. The part x-1 being normally in circuit is with the fine wire upon the shunt magnet wound and traversed by the current in the same direction so as to tend to produce similar poles N. N. or S. S. on the corresponding pole pieces of the magnets M and N. The part p' is only in circuit when the lamp is cut out, and then the current being in the opposite direction produces in the main magnet, magnetism of the opposite polarity.

The operation is as follows: At the start the carbons are to be in contact and the current passes from the positive binding post K to the lamp frame, carbon-holder, upper and lower carbon, insulated return wire in one of the side rods and from there through the part x' of the wire on the main magnet to the negative binding post. Upon the passage of the current the main magnet is energized and attracts the clamping armature g, swinging the clamp and gripping the rod by means of the gripping jaws e, e. At the same time the armature lever L is pulled down and the carbon separated. In pulling down the armature lever L the main magnet is assisted by the shunt magnet N, the latter being magnetized by magnetic induction from the magnet M.

It will be seen that the armatures L and g are practically the keepers for the magnets M and N and owing to this fact both magnets with either one of the armatures

L and g may be considered as one horseshoe magnet which we might term a compound magnet. The whole of the soft iron parts m, m' g, n, n' and L form a compound magnet.

The carbons being separated, the fine wire receives a portion of the current. Now the magnetic induction from the magnet M is such as to produce opposite poles on the corresponding ends of the magnet N, but the current traversing the helices tends to produce similar poles on the corresponding ends of both magnets and therefore, as soon as the fine wire is traversed by ~~sufficient~~ current, the magnetism of the whole compound magnet is diminished.

With regard to the armature g and the operation of the lamp, the pole m' may be termed as the clamping and the pole n' as the releasing pole.

As the carbons burn away the fine wire receives more current and the magnetism diminishes in proportion. This causes the armature lever L to swing and the armature g to descend gradually under the weight of the moving parts until the end p, Fig. 1, strikes a step on the top-plate B. The adjustment is such that when this takes place the rod R is yet gripped securely by the jaws e, e. The further downward movement of the armature lever being prevented, the arc becomes longer as the carbons are consumed and the compound magnet is weakened more and more until the clamping armature g releases the hold of the gripping jaws e, e, upon the rod R and thr rod is allowed to drop a little, shortening thus the arc. The fine wire now receiving less current the magnetism increases and the rod is clamped again and slightly raised if necessary. This clamping and releasing of the rod continues until the carbons are consumed. In practice the feed is so sensitive that for the greatest part of the time the movement of the rod cannot be detected without some actual measurement. During the norman operation of the lamp the armature lever L remains stationary or nearly so in the position shown in Fig. 1.

Should it arise that owing to an imperfection in the rod the same and the carbons drop too far so as to make the arc too short or even bring the carbons in contact, then a very small amount of current passes through the fine wire and the compound magnet becomes sufficiently strong to act, as on the start, in pulling the armature lever L down and separating the carbons to a greater distance.

It occurs often in practice that the rod sticks in the guides. In this case the arc reaches a great length until it finally breaks; then the light goes out and frequently the fine wire is injured. To prevent such an accident, I provide my lamp with an automatic cut-out. This cut-out operates as follows:- When upon a failure of the feed the arc reaches a certain predetermined length, such an amount of current is diverted through the fine wire that the polarity of the compound magnet is reversed. The clamping armature g is now moved against the shunt magnet N until it strikes the releasing pole n' .

As soon as the contact is established the current passes from the positive binding post over the clamp r, armature g, insulated shunt magnet and the helix p' upon the main magnet M to the negative binding post. In this case the current passes in the opposite direction and changes the polarity of the magnet M, at the same time maintaining, by magnetic induction, in the core of shunt magnet, the required magnetism without reversal of polarity and the armature g remains against the shunt magnet pole n'. The lamp is thus cut out as long as the carbons are separated.

The cut out may be used in this form without any further improvement, but I prefer to arrange it so that if the rod drops and the carbons come in contact, the arc is started again. For this purpose I proportion the resistance of the part p' and the number of the convolutions of the wire upon the main magnet so that when the carbons come in contact, a sufficient amount of current is diverted through the carbons and the part x' to destroy or neutralize the magnetism of the compound magnet. Then the armature g having a slight tendency to approach to the clamping pole m' comes out of contact with the releasing pole n'. As soon as this happens the current through the part p' is interrupted and the whole current passes through the part x'. The magnet M is now strongly magnetized, the armature g is attracted and the rod clamped at the same time the armature lever L is pulled down out of its normal position and the arc started.

In this way the lamp cuts itself out automatically when the arc gets so long and reinserts itself automatically in the circuit if the carbons drop together.

It will be seen that the cut out may be modified without departing from the spirit of my invention as long as the shunt magnet closes a circuit including a wire upon the main magnet, and continues to keep the contact closed being magnetized by magnetic induction from the main magnet. It is also obvious to say that the magnets and armatures may be, of any desired shape.

I CLAIM AS MY INVENTION:-

1st. The combination in an arc lamp, of a main and a shunt magnet, an armature lever to draw the arc, a clamp and an armature to act upon the clamp, a clamping pole and a releasing pole upon the respective cores, the cores, poles armature lever and clamping armature forming a compound magnet, substantially as set forth.

2nd. The combination in an electric arc lamp, of a carbon holder and its rod, a clamp for such carbon holder, a clamping armature connected to the clamp, a compound electro magnet controlling the action of the clamping armature and electric circuit connections, substantially as set forth for lessening the magnetism of the compound magnet when the arc between the carbons lengthens and augmenting the magnetism of the same when the arc is shortened, substantially as described.

3rd. The combination with the carbon holders in an electric lamp, of a clamp around the rod of the upper car holder, the clamping armature connected with said clamp, the armature lever and connection from the same to the cl the main and shunt magnets and the respective poles of th same to act upon the clamping armature and armature lever respectively, substantially as set forth.

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4th. In an electric arc lamp, a cut-out consisting of a main magnet, an armature, and a shunt magnet having an insulated pole piece, and the cut-out circuit connections through the pole piece and armature, substantially as set forth.

5th. In an electric arc lamp, the combination with the carbon holder and magnets, of the armatures L and g, link e′ clamp r and lever t and the spring s′ for the purposes set forth.

6th. In an electric arc lamp, the combination with two upright magnets in the main and shunt circuit respectively, having curved pole pieces on one end and converging pole pieces on the other end, of a flat z shaped armature lever between the curved pole piece and a clamping armature between the convergent pole pieces, substantially as described.

7th. The combination in an electric arc lamp, of an electromagnet in the main circuit and an electro magnet in the shunt circuit, an armature under the influence of the poles of the respective magnets and circuit connections controlled by such armature to cut out or shunt the lamp, substantially as specified, whereby the branch circuit is closed by the magnetism of the shunt magnet and then kept closed by induced magnetism from the main magnet, substantially as set forth.

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8th. The combination with the carbon holder and rod and the main and shunt magnets, of a feeding clamp, an armature for the same, clamping and releasing poles upon the cores of the respective magnets and circuit connections through the clamping armature, substantially as specified, for shunting the current when the arc between the carbons becomes abnormally long, substantially as set forth.

9th. The combination with the carbon holding rod and a clamp for the same, of an armature upon the clamp, a shunt magnet, the pole of which acts to release the clamp, a main magnet with a two part helix, one portion being in the main circuit and the other portion in a shunt or cut out circuit, the clamping armature acting to close said cut out circuit when the arc becomes too long, and to break the shunt circuit when the carbons come together, substantially as set forth.

10th. The combination with the carbon holders of two magnets, one in the main circuit and the other in a shunt circuit, and an armature lever to draw the arc, and a feeding mechanism and pole pieces upon the electro magnets, to act upon the feeding mechanism, substantially as specified.

11th. The combination with the carbon holders, of two magnets, one in the main circuit and the other in a

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shunt circuit, an armature lever between two poles of such electro magnets to draw the arc, pole pieces upon the other two poles of the electro magnets, and a feeding mechanism between and acted upon by such pole pieces substantially as specified.

12th. The combination with the carbon holder, of a tubular clamp surrounding the same, an armature lever connected to ~~said tubular~~ clamp and electro magnets in the main and shunt circuits respectively, and an armature upon the tubular clamp adjacent to ~~the~~ lateral poles of the electro magnets, substantially as set forth.

New York N. Y.
Jan. 16 1886
Signed in the presence of
Chs. H. Smith
Geo. T. Pinckney

Nikola Tesla

B.C.

Impts. in Electric Arc Lamps

References.

24348

A	Base
a	Washers
b	"
B	Top plate
f,	Guide
e'	Link
G	Armature
L	" lever
M	Main magnet
m	Pole piece
m'	" "
N	Shunt magnet
n	Pole Piece
n'	" "
o	Hook
p	Part of L
q	Support
R	Rod
S	Columns
S'	Spring
S²	Cover
t	Lever
v	Pivots
w	Bearings
x	Jaw

Fig. 1.

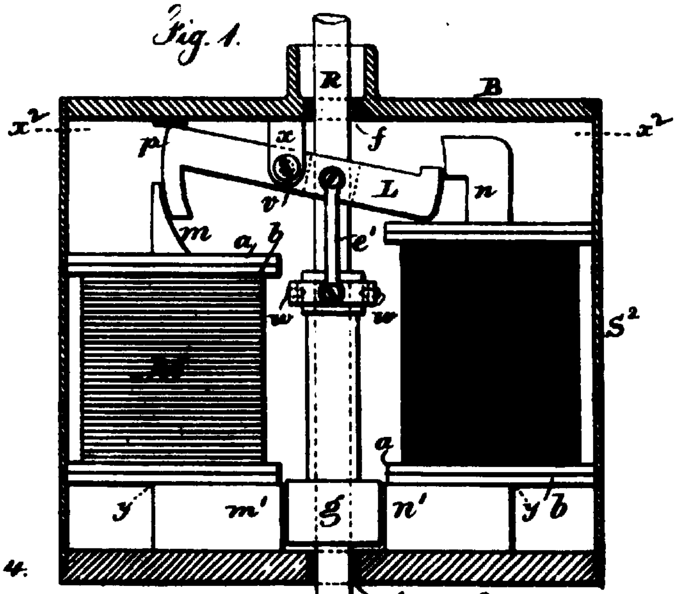


Fig. 4.

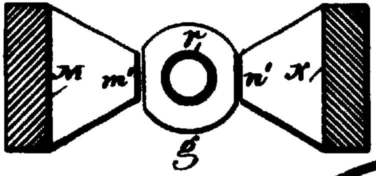
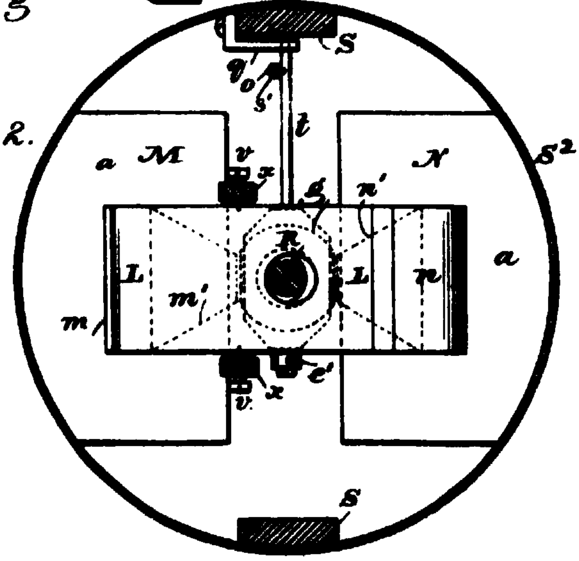


Fig. 2.



New York N.Y. Jan 18. 1886

Certified to be the drawings referred to in the specification hereunto annexed

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Witnesses
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Impts. in Electric Lamps.

24348

References

A.	Base
a	Washers
b	"
e	Gripping Jaws
e'	Link
f	Guide
g	Armature
K	Binding Screw
K'	" "
L	Armature lever
M	Main Magnet
m'	Pole Piece
n'	" "
o	Hook
R	Rod
r	Clamp
q	Support
S.	Columns
S'	Spring
S²	Cock
t	Lever
v	Pivots
w	Bearings
x	Jaws
N	Shunt magnet
m.	Pole Piece
x'	Part of magnet M
p'	" " " "
B	Top Plate
p.	Part of L

Fig. 3.

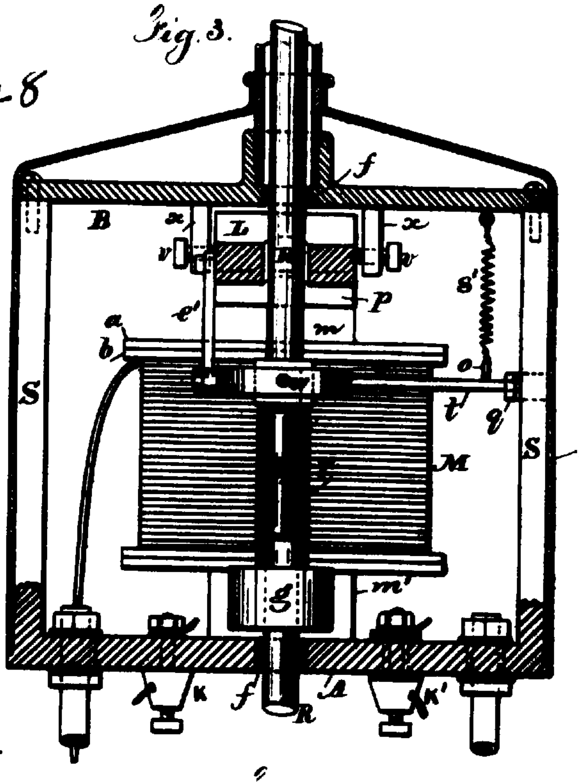


Fig. 6.

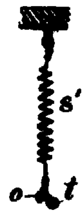


Fig. 5.

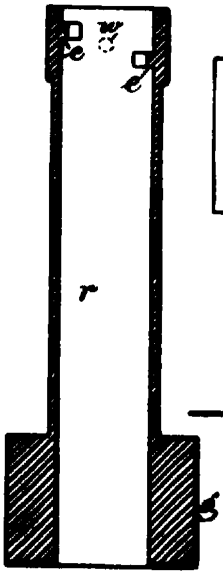
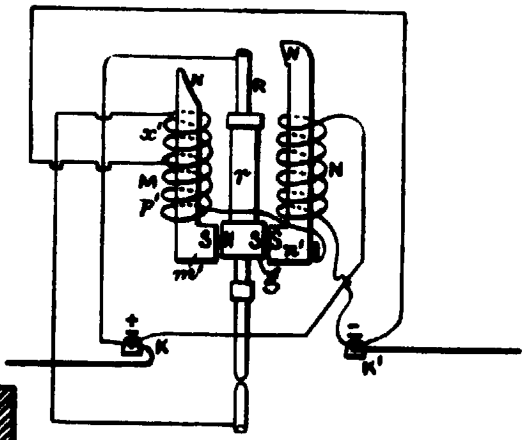


Fig. 7.



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